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Renewable energy and hydropower utilization tendency worldwide

Darmawi [a,*], Riman Sipahutar [a], Siti Masreah Bernas [b], Momon Sodik Imanuddin [b]

[a] Mechanical Engineering Department, Faculty of Engineering, Sriwijaya University, Indonesia
[b] Faculty of Agriculture, Sriwijaya University, Indonesia

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ABSTRACT

Tidal energy could convert into power on the basis of height difference (Tidal Barrages) and on the basis of flow speed (Tidal Current). The studies have shown that tidal barrages have some disadvantages concerning the environmental impacts and the limits of availability of economic sites. Tidal current seems to have much advantages concerning the environmental impacts and technology advancement and simplicity in application. This article discusses the tendency of utilization of small hydropower energy generation system in the coming decades regarding the concern of environment impacts and electricity needs worldwide.

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1. Introduction

Hydropower is predicted to take greater part of electricity generated from renewable energy. By far in 2005, some 2950 TWh of electric energy is generated from hydropower or 90% of renewable energy and 16% of total electric energy worldwide, a bit larger than the nuclear power, which provided 2771 TWh in 2005 [1]. Some country has shown that hydropower is the largest source of domestic electricity, for example Canada (60%), Brazil (84%), Switzerland (55%), Iceland (80%) and Norway (98%). Unfortunately, the potential of hydropower is not equally distributed across the world.

Fig. 1 shows varied percentages between regions in hydropower utilization. Fig. 1 also shows different hydro energy potential, where Asia is the largest hydropower potential in the globe, with 6,800,000 GWh/year. The world total technical feasible potential is 14,218,000 GWh/yr. It consist of Asia 6,800,000 GWh/yr, South America, 2,700,000 GWh/yr, Africa 1,750,000 GWh/yr, North and Central America 1,663,000 GWh/yr, Europe 1,035,000 GWh/yr [4].

2. Hydropower in Asia

Asian countries, mainly China, are between countries which expand extensively their hydro energy potential. The world's hydroelectric systems will add 157.8 GW in 2008, and nearly 83% of this expansion is placed in Asia ([2,5,14]). China in Eastern Asia builds 80 GW or 61% of 130 GW planned to expand in Asia. At the end of 2010, China has already installed 210 GW hydroelectric capacity [3]. Myanmar in 2000 had 365 MW of installed hydropower, but plans call for installing 39,600 MW in the next two decades. India and Bhutan in Western Asia have hydropower potentials of 169 GW, 70% of which remains undeveloped. Hydropower potential of 15.5 GW is currently under construction in the region (Bhutan 1.2 GW and India 13.9 GW). Nepal and

* Corresponding author. Tel.: +62 812 788 6884.
E-mail address: d_bayin2009@yahoo.com (Darmawi).

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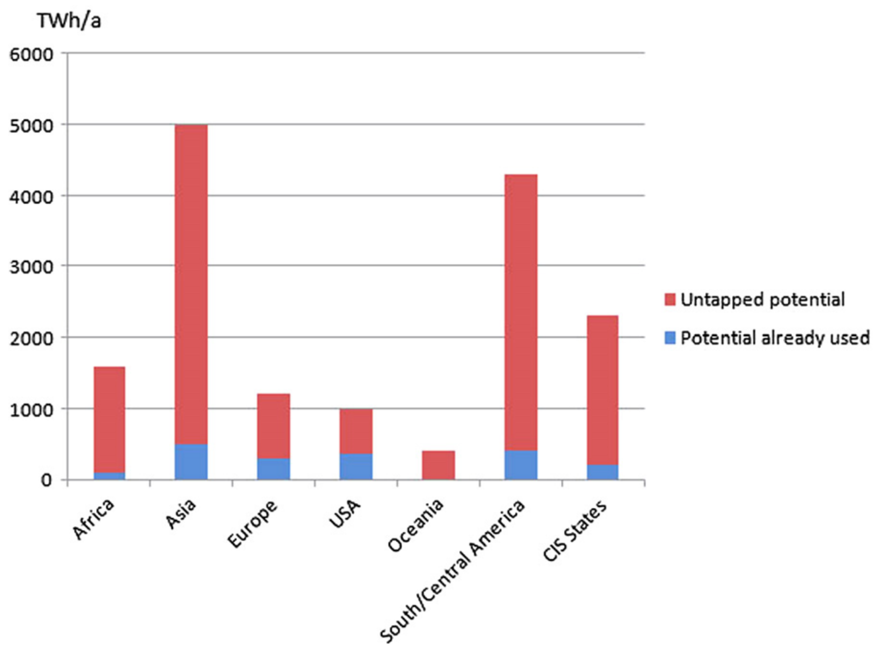

Fig. 1. Hydropower potential, untapped and already used power.
Source: Seifried [1]

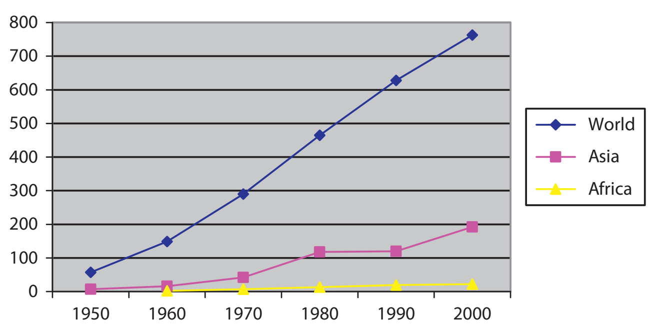

Fig. 2. World hydroelectricity system installation increment in decades in kWh/p/y. Developed from: Sternberg [2].

Bhutan are rich in hydropower resources. Pakistan in South Asia, has hydropower potential more than 38,000 MW. In Middle East, there are limited sites for hydropower, only Iran and Iraq have project under development. Iran is seeking to develop some 2.6 GW and Iraq 0.3 GW [3]. ASEAN countries' total hydro potential is 202417 MW. According to IEA and ESCAP report, installed hydro capacity in ASEAN region in 2000 is 17.913 MW [16]. It is now more than 105.000 MW of hydro capacity under construction in the world.

3. The poverty and electricity

According to International Hydropower Association (2011), it is estimated that 1.4 billion people live without electricity around the globe. Some other says 1.6–2.0 billion people live in the dark and smoke filled home [7,6]. Electricity is one of the pillars on which education and health lie on. Electricity is strongly related to the policy to step-up the economic sustainability and a better quality of life, reducing the poverty and diminishing the inequality.

In Bangladesh, India and Pakistan 570 million people have no access to electricity. Millions of people worldwide have no access to electricity. According to Kaygususz [6], it is approximately 589 million people in Africa, 587 million people in Sub-Saharan Africa, 809 millions in developing Asia, 614 million in South Asia and 1453 million in all developing countries. Data show the inter-relation between the poverty and the electricity availability. Energy consumption of African people especially sub-Saharan Africa is 248 Kgoe or half of the world average, while the population in sub-Saharan Africa in 1999 is estimated to be 642 million people or over 80% of the African total population [9] (Fig. 2).

4. Small hydropower and rural electrification

According to Giles [10], some hydropower schemes cause global warming as much as fossil fuel plants as the previous forested areas emit greenhouse gases in the form of methane and nitrous oxide which have global warming effect 25 and 300 times greater than carbon dioxide respectively. Other environmental concerns are highlighted by Harrison et al. [12] on the problem of sediment transport and river ecology. The International Energy Agency has also reported several other negative impacts of major and medium scales that are being associated with large hydropower projects. Many large hydropower projects create social problems worldwide. High Aswan Dam as the one that has 6000 km^2 surface area and water volume of 162 km^3 creates downstream and up-stream effects, methylmercury bioaccumulation, emission of greenhouse gases and limitation of biodiversity. High Aswan Dam hydro-electric development resulted in the relocation of more than 100,000 people to make way for reservoir. Migration of large number of people resulted in harmful social effects [13].

Very small hydro plants do not suffer from such environmental and social problems, not only because the scale of the technology but also due to the insignificant storage of water. Mostly mini-, micro- and pico-hydropower do not form a barrier of aquatic life. Small hydropower plants are now recognized as important technology to rural populations, many of which do not have access to electric power.

Ocean covers approximately 71% of earth surface and holds a large amount of energy more than 2×10^3 TW, which is mostly

untapped renewable energy on the planet. Ocean energy is available in some forms, including tide, wave, tidal current, thermal energy conversion. Among them hydro energy is the most highlighted because of the advantages including the long-time predictability, large potential resource and high energy density which is about 832 times greater than that of wind. On the basis of large potential, clean energy necessities of the world and low operating cost, the hydro energy will probably take an important role in coming decades in electricity generation specifically in remote areas and rural areas where electricity grid is unable to reach. Laos in South East Asia with population of 6.5 millions spread across mountainous terrain which covers three quarters of the land area uses pico-hydropower as do the countries with small hydropower.

5. Future hydropower tendency

Renewable energy is of interest to all energy communities to cover the increasing energy deficit, where hydropower, wind energy and photovoltaic seem to be optimum choices among the renewables available today. Hydro energy can be harnessed from the water current by simply utilizing the velocity of the water stream. The power can be extracted from the ocean and river current by using submerged turbine, which are similar to wind turbine, capturing the energy through the process of hydrodynamic. The use of kinetic energy of stream is considered to be a strong alternative in accordance with the large potential and clean energy. The technology of submerged turbine is fit to the requirements of free greenhouse gases emission, low operating cost and low noise transmission systems and nearly existed in most sites in the globe. With these reasons, the use of kinetic energy predicted tends to increase in the domain of kinetic energy conversion in coming decades rather than potential energy conversion worldwide. Mukrimin Sevket [15] expected that the world renewable energy generation will reach 5.8 trillion kWh by 2020, where hydroelectricity will share 4.4 trillion kWh from total or 76%.

Some countries which have numerous water energy resources use hydropower to fulfill their electric domestic needs, such as Norway (98.25%), Brazil (85.56%), Venezuela (67.17%) of installed capacity in 2009. Sternberg [17] reported that installed hydropower worldwide raise significantly from the year 1950 to 2000. In Africa, there is an increment of 4461 percent from 1950 to 2000, in Asia 2418 percent, in Europe 782 percent, in North America 234 percent, Oceania 1307 percent, South America 4954 percent. The world total increment of installed hydropower from the year 1950 to year 2000 is 721 percent or from 92,105 MW to 756,000 MW. These data represent a great tendency to utilize the hydro energy for electricity in coming decades worldwide.

6. Conclusions

Small hydropower which converts the kinetic energy of river stream or ocean current into electrical energy seems a promising alternative source of energy generation to fulfill electric necessity in remote areas. The choice of small hydropower is also backed up by the international effort to reduce greenhouse gas emission in the atmosphere.

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